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15EC54

Fifth Semester B.E. Degree Examination, Aug./Sept.2020 Information Theory and Coding

Time: 3 hrs.

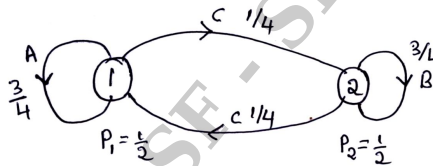
Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Derive an expression for average information content (entropy) of long independent sequence. (04 Marks)
- b. Consider an information source modeled by a discrete ergodic Markoff random process whose graph is shown in Fig. Q.1(b). Find the source entropy H and the average information content per symbol in messages containing one, two and three symbols that is, find G_1 , G_2 and G_3 . (12 Marks)

Fig. Q.1(b)



OR

- 2 a. A code is composed of dots and dashes. Assuming that a dash is 3 times as long as a dot and has one third the probability calculate the information in dot and dash. (04 Marks)
- b. Design a system to report quantized into three levels: information is to be transmitted a model for the source and c
 - i) On the average, during a reporting interval, 200 cars were heading straight, 100 were turning left, and 100 cars were turning right.
 - ii) Out of 200 cars that reported heading straight during a reporting period, 100 of them (on the average) reported going straight during the next reporting period, 50 of them reported turning left during next period, and 50 of them reported turning right during the next period.
 - iii) On the average out of 100 cars that reported as turning during a signaling period, 50 of them continued their turn during the next period and the remaining headed straight during the next reporting period.
 - iv) The dynamics of the cars did not allow them to change their heading from left to right or right to left during subsequent reporting periods. (12 Marks)

Module-2

- 3 a. Consider a source with Alphabet $S = (A, B, C, D)$ with the corresponding probabilities $P = (0.1, 0.2, 0.3, 0.4)$. Find the code words for symbol using Shannons encoding algorithm. Also find the source efficiency and redundancy. (06 Marks)
- b. Consider the following source:
 $S = (A, B, C, D, E, F)$
 $P = (0.10, 0.15, 0.25, 0.35, 0.08, 0.07)$
 Find the codewords for the source using Shannon Fano-Algorithm. Also find source efficiency and redundancy. (06 Marks)
- c. Illustrate with example whether the code is uniquely decodeable or not by applying kraft inequality. (04 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

OR

- 4 a. An information source produces a sequence of independent symbols having the following probabilities:

| A | B | C | D | E | F | G |
|-----|-----|-----|-----|------|------|------|
| 1/3 | 1/3 | 1/9 | 1/9 | 1/27 | 1/27 | 1/27 |

Construct binary code using Huffman encoding procedure and find its efficiency and redundancies. (08 Marks)

- b. Discuss the following coding technique with example:

i) Arithmetic coding ii) Lempel-zev algorithm.

(08 Marks)

Module-3

- 5 a. The Joint probability matrix of a channel is given by

$$P(xy) = \begin{bmatrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.1 & 0.10 & 0 \\ 0 & 0 & 0.20 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{bmatrix}$$

Compute: i) $H(X)$ ii) $H(X,Y)$ iii) $H\left(\frac{Y}{X}\right)$ iv) $H\left(\frac{X}{Y}\right)$

(08 Marks)

- b. The noise characteristics of channel as shown in Fig.Q.5(b). Find the channel capacity.

(05 Marks)

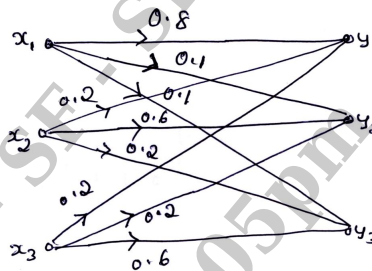


Fig.Q.5(b)

- c. State the properties of mutual information.

(03 Marks)

OR

- 6 a. A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected through a voice grade telephone line, usable bandwidth of 3kHz and an output S/N of 10db. Assume that the terminal has 128 characters and data is sent in an independent manner with equal probabilities.

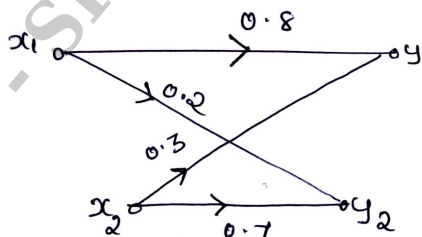
i) Find the average information per character

ii) Find capacity of the channel

iii) Find the maximum rate at which data can be sent from the terminal to the computer without error. (08 Marks)

- b. Find the mutual information for the channel shown in Fig.Q.6(b). Given that $P(x_1) = 0.6$ and $P(x_2) = 0.4$

(08 Marks)



FigQ.6(b)

Module-4

- 7 a. For a systematic (6, 3) linear block code the parity matrix P is given by

$$P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

Find all possible code vector.

(05 Marks)

- b. Construct the standard array for a (6, 3) linear block code whose generator matrix is given below:

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

Decode the received vector 111100

(06 Marks)

- c. For a (7, 4) binary cyclic code the generator polynomial is $g(x) = 1 + x + x^3$. Obtain code word for the message 1010 in systematic and non systematic form.

(05 Marks)

OR

- 8 a. Design an encoder for the (7, 4) binary cyclic code generated by $g(x) = 1 + x + x^3$ and verify its operation using the message vector (0101).
- b. For (7, 4) cyclic code, the received vector $z(x) = 1110101$ and generator polynomial is $g(x) = 1 + x + x^3$. Draw the syndrome calculation circuit and correct the single error in the received vector.
- c. Define Hamming weight, Hamming distance and minimum distance with example.

(06 Marks)

(06 Marks)

(04 Marks)

Module-5

- 9 a. Write an explanatory note on Golay code.
- b. The convolution encoder has the following two generator sequence $g^{(1)} = (111)$, $g^{(2)} = (101)$.
- Draw the convolution encoder
 - Find the output for the message 10011 using time domain approach.
- c. Explain Viterbi algorithm.

(04 Marks)

(06 Marks)

(06 Marks)

OR

- 10 a. Consider a (3, 1, 2) convolution encoder with $g^{(1)} = (110)$, $g^{(2)} = (101)$ and $g^{(3)} = (111)$.
- Draw the encoder block diagram
 - Draw state table
 - Draw state transition table
 - Draw state diagram
 - Find the encoder output by traversing through the state diagram for input message sequence of (11101)
 - Draw code trellis and obtain the output of the encoder for the same input sequence of (11101).
- b. Briefly explain BCH codes.

(12 Marks)

(04 Marks)

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